Claims:

1. A carbon nanotube-based field emission device comprising:

   a cathode electrode; and

   a carbon nanotube array extending substantially perpendicularly from the cathode electrode and having a growth end embedded in the cathode electrode and an opposite root end;

   wherein the growth end of the carbon nanotube array is in electrical contact with the cathode electrode, and the root end defines a substantially planar surface.

2. The field emission device as described in claim 1, wherein a variation in flatness of the planar surface is less than 1 micron.

3. The field emission device as described in claim 1, wherein the cathode electrode is made of copper.

4. The field emission device as described in claim 1, wherein the carbon nanotube array comprises a plurality of carbon nanotubes, each of which has an open tip.

5. The field emission device as described in claim 1, wherein a height of the carbon nanotube array is in the range from 5 microns to 10 mm.

6. The field emission device as described in claim 1, wherein the height of the

carbon nanotube array is in the range from 10 to 500 microns.

7. The field emission device as described in claim 1, wherein an insulative barrier having a height just exceeding the planar surface of the root end is formed adjacent the carbon nanotube array and at least a gate electrode is formed on the barrier such that the gate electrode is separated from the cathode electrode.

8. The field emission device as described in claim 7, wherein the root end of the carbon nanotube array almost reaches the interface between the barrier and the gate electrode.

9. A carbon nanotube-based field emission device comprising:

a carbon nanotube array which grows from a root end and extends to a growth end; and

a cathode electrode formed on and covering the growth end of the carbon nanotube array;

wherein the root end defines a substantially planar surface which is exposed outwardly and acts as an emitter, and the growth end is substantially embedded into the cathode electrode.

10. The field emission device as described in claim 9, wherein a flatness of the planar surface is less than 1 micron.

11. The field emission device as described in claim 9, wherein the carbon nanotube array comprises a plurality of carbon nanotubes, each of which has an open tip.

12. The field emission device as described in claim 9, wherein a height of the carbon nanotube array is in the range from 5 microns to 10 mm.

13. The field emission device as described in claim 9, wherein the height of the carbon nanotube array is in the range from 10 to 500 microns.

14. The field emission device as described in claim 9, wherein at least a gate electrode is formed adjacent the carbon nanotube array at a height above the planar surface of the root end.

15. The field emission device as described in claim 14, wherein the gate electrode is supported by an insulative barrier formed adjacent the carbon nanotube array, such that the gate electrode is separated from the cathode electrode.

16. A method of making a carbon nanotube-based field emission device, comprising steps of:

providing a catalyst layer;

growing a carbon nanotube array on said catalyst layer wherein carbon nanotubes in said array extend from said catalyst layer with roots and define different heights with tips;

applying a cathode electrode to said tips of said carbon nanotubes;

separating said carbon nanotubes from said catalyst layer and exposing said roots; and

providing a gate electrode beside said roots.

17. The method as described in claim 16, wherein said gate electrode is supported by a barrier which is seated upon the cathode electrode.

18. The method as described in claim 17, wherein a height of said barrier is similar to a common height of said carbon nanotubes measured from the cathode electrode.

19. The method as described in claim 17, wherein said cathode electrode is originally supportably seated upon said barrier for applying said cathode electrode to the tips after growth of said carbon nanotubes.